



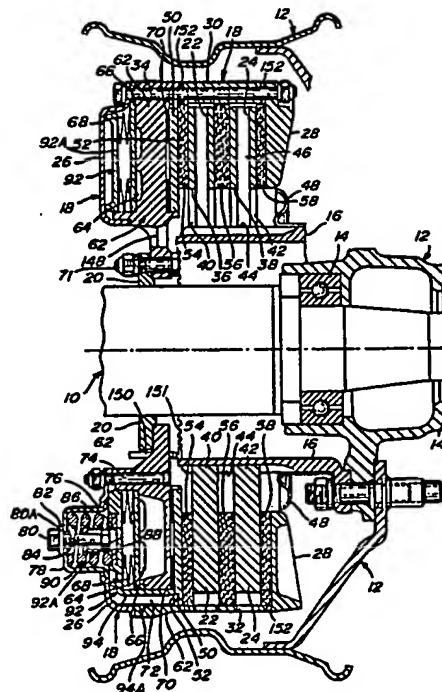
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(54) Title: BRAKE ASSEMBLY

(57) Abstract

An improved truck disc brake using a spring loaded safety brake and a pneumatic bladder (68) for releasing the safety brake as well as a service brake enhancing bladder (70) and a pair of rotor brake discs (22, 24). The brake discs (22, 24) are ventilated and include ventilation channels (46) extending radially thereof and vent air is deflected into the brake assembly by means of a scoop (134) on the exterior of the housing (18) passing through openings (148) in the housing and the rotor brake discs (22, 24) act as an impeller moving the ventilation air outwardly thereof to dissipate the heat. A wear gauge (110, 112, 132) is provided to determine the wear of the brake linings (52, 56, 58) and discs (22, 24) and a quick release valve (126) is mounted in the brake assembly adjacent the pneumatic bladder (70) related to the service brake, to quickly release the air when required. Temperature sensors (100, 102) are provided within the brake assembly to read the temperature of the brake assembly. A radial groove (142) extends on the friction surface of the radial disc to provide an air cushion between the brake linings (52, 56, 58) and the friction surface (22a, 22b, 24a, 24b) of the disc (22, 24) and to discharge debris.



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BRAKE ASSEMBLY

TECHNICAL FIELD

The present invention relates to disc brakes and more particularly to improvements in large
5 area contact disc brakes for larger vehicles such as trucks, tractor-trailer vehicles in addition to other large wheeled vehicles and aircrafts.

BACKGROUND ART

Canadian Patents 1,112,189, issued November 10, 1981 and 1,140,486, issued February 1, 1983,
10 and U.S. Patent 4,102,438, issued July 25, 1978, Yvon Rancourt, which are incorporated herein by reference, describe a disc brake for heavy road vehicles wherein the brake shoes are in contact with the much larger
15 disc area, and a suitable brake cooling system is provided to cool the disc, thus making disc brakes practical for such vehicles. The present invention is an improvement over the above-mentioned patent.

There are braking systems available on
20 various types of vehicles which include a positive mechanical brake of the type known as a fail-safe brake, that is, where the brakes are applied when pressure is released from the brakes. U.S. Patent 3,547,234, Cummins, December 15, 1970, describes a
25 service brake for earthmoving trucks or tractors which includes a hydraulic brake system using a plurality of discs, and these discs are mechanically preloaded by a spring to provide a fail-safe brake. U.S. Patent 4,057,297, November 8, 1977, Beck et al,
30 includes a brake system which has been preloaded by means of a spring, including the discs of the type described in the Cummins Patent. This pressurized air operated system uses a series of valves to modify the

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pressure exerted on the torque converter in order to avoid damage to the differential. This is a system that is utilized in very heavy machinery such as tractors, etc. These patents represent the state of the art in terms of fail-safe type brake systems using preloaded mechanical devices such as springs. The structures are complicated by the need to be adapted on heavy vehicles. What is required is a fail-safe type brake system of simple construction using pneumatic pressure for releasing the brakes and utilizing a simple disc brake construction of the type described in the Rancourt Patent wherein the disc is mounted to the adapter sleeve of a wheel on the vehicle and the brake housing is mounted to the vehicle on a dead axle.

It is also recognized that a major problem with large contact-area annular disc brakes of the type described in the above patents is heat. Great strides in improving heat dissipation were achieved with the introduction of vaned discs as described in U.S. Patent 4,102,438. However, vented discs of the type described required a thicker disc to retain the same strength. It was found for instance that it was not possible to house more than one cast-iron vented disc in an in-wheel brake housing, thus reducing the flexibility of design of such brakes, especially where multiple discs might be an advantage.

Another problem which has had a serious social impact is brake failure due to wear. Presently, there is no known reliable brake wear gauge for determining the remaining life of a particular set of brakes linings on a truck vehicle. It is necessary to remove housing parts on the wheel in order to examine and measure the remaining thickness of the lining and the brake disc. Since such examination adds to the down time of the truck

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or tractor- trailer, the tendency of the operator or driver- operator is to delay such inspection, with sometimes disastrous results, often costing innocent lives in highway accidents due to failed brakes of such large vehicles.

DISCLOSURE OF INVENTION

It is an aim of the present invention to provide a disc brake for heavy road vehicles which relies on mechanical means for applying or actuating the brakes.

It is a further aim of the present invention to provide automatic security in the event of a malfunction in the braking system.

It is a further aim of the present invention to provide a parking brake integrated with the disc brake assembly within the same housing in order to free up the axle.

It is a further aim of the present invention to provide a disc brake assembly which has a greater capacity to dissipate heat.

It is still a further aim of the present invention to provide a disc brake assembly which has an improved means for monitoring temperature and wear in a brake assembly.

It is a further aim of the present invention to provide an aircraft disc brake assembly which has means to rotate the wheels of an aircraft to provide rotation of the wheels before touch down so that the rate of rotation approximates the rate of rotation after touch down.

A construction in accordance with the present invention includes a disc brake assembly for a vehicle wheel on a vehicle, wherein the wheel includes a hub journaled through a wheel mounting means on the vehicle. The brake assembly includes a

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housing mounted to the vehicle and at least a radial disc within the housing mounted to the wheel. The disc has at least a first radial planar friction surface, and a brake shoe is provided adjacent the planar friction surface movable axially towards and away from the first friction surface of the disc for friction engagement therewith and release thereof. Means are provided for restraining the brake shoe means from rotating with the disc. An intermediate wall member is mounted within the housing and is fixed thereto, parallel with the first radial disc friction surface, and located such that the brake shoe means moves between the intermediate wall and the radial disc. A movable plate means is mounted for axial movement within the housing between the intermediate wall and a housing wall, such that the intermediate wall is between the movable plate means and the brake shoe means. Rigid link members extend between the plate means and the brake shoe means through the intermediate wall such that the plate means moves axially with the brake shoe means. Spring means extend between the housing wall and the plate means such that the spring continually urges against the plate means to press the brake shoe assembly means against the first friction surface of the disc. A fluid bladder means is provided between the intermediate wall and the plate means whereby the bladder, when expanded, forces the plate means to overcome the spring means to release the brake shoe means from the friction surface of the disc.

In a more specific embodiment of the present invention, the brake shoe assembly means includes a backing plate mounting the brake shoes, and the backing plate extends parallel to the intermediate wall and is in direct contact with the link members. A second pneumatic bladder is provided

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between the backing plate and the intermediate wall such that, when the brakes are being actively applied, pneumatic pressure is applied to expand the second bladder such as to actively urge the brake shoe assembly means against the first friction surface of the disc and supplementing the action of the spring against the movable plate means. In certain circumstances, while the second bladder is being inflated, the first bladder is deflated.

10 In a more specific embodiment of the present invention, the radial disc is provided with a second radial friction surface on the other side of the disc relative to the first friction surface, and a second brake shoe means is mounted within the housing adjacent the second friction surface of the disc, and the disc is mounted to the wheel through an adapter sleeve by means of axial splines such that the disc is capable of slight axial movement. The second bladder could alternatively be mounted between a backing plate for the second brake shoe means and the housing.

20 In a more specific embodiment, the intermediate wall member is mounted to a radial mounting plate mounted to the wheel mounting means of the vehicle, and the housing is fixedly mounted to the mounting plate.

30 In a still more specific embodiment of the present invention, the housing means is an annular housing provided with a central axial opening through which an axle forming part of the wheel mounting means of the vehicle extends therethrough, and the mounting plate is an annular ring mounted to the axle while the disc is an annular disc mounted on axial splines of an adapter sleeve projection extending from the wheel through a central opening of the disc.

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A construction in accordance with a further aspect of the present invention comprises a brake assembly for a vehicle wheel having a brake housing adapted to be contained in the wheel, mounting means for securing the housing to the vehicle, at least an annular rotor disc mounted within the housing for rotation with the wheel, the disc having a plurality of circumferentially spaced channels extending from the periphery of the disc towards the center to communicate with central openings at the inner margin of the annular disc such that air can pass from the central openings at the inner margin of the annular disc to exhaust at the outer periphery thereof in order to dissipate heat generated at the disc, means defining openings in the housing to allow air flow from the exterior of the housing through the housing openings, means for directing the air flow through the housing to the central openings in the disc, and deflector means mounted on the exterior of the housing for diverting air to the openings in the housing.

In another aspect of the present invention there is provided an annular rotor disc for a disc brake assembly having at least one radial planar braking surface, brake shoe means for engaging the braking surface of the disc, characterized in that at least a shallow groove extends across the braking surface generally radially thereof whereby an air cushion is provided between the rotor disc and the brake shoe means when the brake shoe means is released from the braking surface of the disc by reason of the "pumping" of the air from the center of the disc radially towards the periphery of the disc during rotation of the disc. The groove also acts, when the brake are being applied, as a channel for

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draining liquid and other debris resulting from the frictional contact of the brake shoe means and the braking surface of the disc.

In another aspect of the present invention

5 a construction includes a disc brake assembly for a vehicle wheel wherein the wheel includes a hub journaled to an axle on the vehicle, the disc brake assembly is within the confines of the wheel and concentric with the axle, the disc brake assembly

10 includes a housing mounted to the vehicle and at least a radial disc within the housing and means mounting the disc to the wheel, the disc having at least a first radial planar friction surface, a first brake shoe provided adjacent the first planar

15 friction surface of the disc, movable axially towards and away from the first friction surface of the disc for friction engagement therewith and release thereof, means provided for restraining the first brake shoe from rotating with the disc, an

20 intermediate wall member mounted within the housing and fixed thereto extending parallel with the radial disc and located such that the first brake shoe moves axially between the intermediate wall and the radial disc, a movable spring abutment means mounted for

25 axial movement within the housing between the intermediate wall and the housing wall such that the intermediate wall is between the movable spring abutment means and the first brake shoe, pusher link members extending between the spring abutment means

30 and the brake shoe passing through the intermediate wall such that the spring abutment means moves axially with the brake shoe, spring means extending between the housing wall and the spring abutment means such that the spring means urges against the

35 spring abutment means to press the brake shoe against the friction surface of the disc, a first fluid

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bladder being provided between the intermediate wall and the spring abutment means whereby the first bladder when expanded forces the spring abutment means to overcome the spring means to release the
5 brake shoe from the friction surface of the disc, thus releasing the parking brakes, a second bladder being provided between the intermediate wall and the brake shoe such that when expanded service brakes will be applied by the application of the brake shoe
10 to the friction surface of the disc characterized in that quick release valve means are mounted to the intermediate wall and communicate with the second bladder in order to evacuate gas from the second bladder to accelerate the modulation of the second
15 bladder and to circulate the gas along the intermediate wall in order to help dissipate heat therefrom.

In a more specific embodiment of the present invention thermal-sensing means are as-
20 sociated with the intermediate wall and with a housing wall and means are provided for communicating the data from the sensing means to a display means.

In a further aspect of the present invention there is provided a disc brake assembly for
25 a vehicle wheel wherein the assembly comprises a brake housing defining an interior chamber, mounting means for securing the housing to a vehicle, at least an annular rotor disc mounted within the housing, the brake disc having at least one planar braking
30 surface, means mounting the annular rotor disc to the wheel, at least one brake shoe means disposed within the housing on the planar braking surface side of the disc and mounted for axial movements towards and away from the disc, the brake shoe means including brake
35 lining means adapted to be in contact with the planar braking surface of the disc, means provided for

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restraining the brake shoe means from rotating with the disc, a movable spring abutment means mounted for axial movement within the housing and rigid pusher link members extending between the spring abutment means and the brake shoe means, spring means extending between the housing wall and the spring abutment means such that the spring urges against the spring abutment means to press the brake shoe means against the first friction surface of the disc and a brake shoe wear sensing means including means indicating changes in the distance between the housing wall and the spring abutment means such that when the brake linings and disc have worn, such wear will be discernible from the brake wear sensing means.

In this specification, parking or safety brakes means the mechanism which allows the brakes to be applied when the vehicle is not in use or a malfunction should occur in the operation of the service brakes. Active or service brakes refers to the mechanism which provides for the brakes to be applied directly by the operator to slow the vehicle when moving on to bring it to a halt. It is understood that vehicle includes aircraft.

25 BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration, a preferred embodiment thereof, and in which:

30 Fig. 1 is a fragmentary axial cross-section taken through a brake assembly in accordance with the present invention;

Fig. 2 is an enlarged fragmentary cross-section of a detail of the brake assembly;

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Fig. 3 is a further fragmentary enlarged axial cross-section taken of a further detail of the brake assembly;

Fig. 4 is an enlarged fragmentary front
5 elevation of the brake assembly;

Fig. 5 is a horizontal cross-section taken along lines 5-5 of Fig. 4;

Fig. 6 is an enlarged fragmentary side elevation of a detail of the present invention;

10 Fig. 7 is an enlarged fragmentary vertical cross-section taken along lines 7-7 of Fig. 6;

Fig. 8 is an enlarged fragmentary cross-section of a detail shown in Fig.1.;

15 Fig. 9 is an enlarged fragmentary front elevation of the brake assembly with parts removed to view further details of the present invention;

Fig. 10 is a fragmentary axial section of another embodiment of a detail of the present
20 invention;

Fig. 11 is an enlarged fragmentary axial section showing still another embodiment of the detail shown in Fig.10;

Fig. 12a is a schematic view of a spring
25 disc which can be used in an embodiment of the present invention; and

Fig. 12b is a graph showing relative spring load characteristics of the spring disc.

MODES FOR CARRYING OUT THE INVENTION

30 Referring to Figs. 1 to 3 the wheel assembly is shown with an axle 10. Axle 10 is a dead axle and bearings 14 mount the wheel 12 for rotation thereabout. An adapter sleeve 16 is mounted to the wheel 12 and extends concentrically over the axle 10
35 within the disc brake housing 18. A mounting ring 20

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is fixed to the axle 10 and the housing 18 is mounted to the mounting ring 20. Two radial vented rotor discs 22 and 24 are shown within the housing 18. The housing 18 includes an annular housing wall 26 on the inboard side of the assembly, an annular housing wall 28 on the outboard side, and the whole is surrounded by a peripheral wall 30. Ventilation openings 32 are provided in the peripheral wall 30. Nut and bolt arrangements 34 secure the housing walls 26, 28, 30 and intermediate wall 62 together to form the housing 18.

The adapter sleeve 16 has axial splines 44 and the annular rotor brake discs 22 and 24 include disc openings 36 and 38 at the inner margins, respectively and the openings are interspersed with teeth 40 and 42. The teeth 40 and 42 engage the splines 44, thereby providing limited axial movement to the discs 22 and 24 while entraining the discs with the wheel 12.

Each brake disc 22 and 24 is provided with generally radial vent channels 46. It has been found that it is possible to maintain brake discs having vented channels within reasonable axial dimensions or thickness, by making the discs out of a composite of aluminum called "DURALCAN". Thus, it is possible to provide two or more brake discs in a space where only one vented cast iron brake disc was previously possible. The openings 36 and 38 of the discs 22 and 24 provide a ventilation passage as will be described later. An annular air deflector 48 is provided on adapter sleeve 16 in the plane of the housing wall 28.

The brake shoe 50 includes an annular backing plate 52 axially movable within the housing 18 to which is mounted a brake lining 54. The backing plate 52, brake lining 54, and annular brake

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lining 56 are provided with peripheral slots and teeth which engage between bolts 34 of the housing to restrain them from rotation but to allow them to slide axially. The brake lining 54 is adapted to frictionally engage the planar radial disc surface 22A. Annular brake lining 56 is provided between the discs 22 and 24 while annular brake lining 58 is mounted to the housing wall 28.

Annular spacing rings 152 are provided in the housing wall 30 and on the removal of the spacing rings 152 the housing will be reduced in axial dimension, thereby compensating for the wear on the linings 54, 56 and 58, and the wear on disc 22 and 24, as will be described later.

An intermediate wall 62 is mounted to the mounting ring 20 on the axle 10 by means of bolt and nut arrangements 71. Of course the intermediate wall 62 may be welded to mounting ring 20. The intermediate wall 62 also serves to support the housing wall 26, cylindrical wall 30, and housing wall 28 by means of the nut and bolt arrangements 74 and 34. Ventilation channels 64 are provided in the intermediate wall 62 while axial ventilation openings 148 are provided in spaced apart relationship near the inner opening of the annular intermediate wall 62.

In the present embodiment a plate 66 is placed against the intermediate wall 62 and is bolted thereto by means of nut and bolt arrangements 74 and 34 as shown. This plate 66 acts to support the bladder 68. Bladder 68 is an annular bladder made of stainless steel sheets, welded together as shown in Fig. 2. Air under pressure is fed to the bladder 68 through the tube 106 and inlet 108. Other gases may also be used to inflate the bladder. Stoppers (not

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shown) may be provided on the plate 66 adjacent the bladder 68 to prevent the bladder 68 from being crushed accidentally.

The spring abutment member 92 is mounted
5 for axial movements relative to the intermediate wall 62. The spring abutment member 92 is in the form of a spider with legs 94 spaced about the periphery of an annular plate 92A and integral therewith. The legs 94 extend through openings 72 in the inter-
10 mediate wall 62. Seals 94A are provided in the openings 72 surrounding the legs 94 in order to prevent dust, oil or other debris from entering any further into the housing. The legs 94 engage the backing plate 52 near the peripheral edge thereof. In view of
15 the stresses on the peripheral edge of the backing plate 52, the backing plate 52 may be constructed with a slight flare in the direction of the legs to compensate for the stresses which would apply when the legs 94 come into contact at the peripheral edge
20 of the backing plate 52. The ends of legs 94 might also be provided with a slight beveled angle to compensate for such stresses.

Springs 90 urge the spring abutment plate 92 towards the brake shoe 50. A plurality of
25 springs 90 are provided in annular spaced apart locations on the housing wall 26, each within a bell cover 78 fitted within a respective opening 76 on the wall 26. The bell covers 78, in one embodiment have a rotary bayonet type of connection to engage the
30 housing wall 26 so that they can be removed in order to replace the springs 90 for instance. A nut 80 having a flange 82 is provided exteriorly of the bell cover 78. The nut 80 engages the threads of bolt 84. The head of the bolt 84 is in a blind sleeve 86 which
35 has a flange 88 and which abuts the coil spring 90. Thus, if it is necessary to remove the tension of the

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springs 90 against the spring abutment plate 92 the nut 80 is rotated to point where the head of the bolt 84 moves the blind sleeve 86 towards the left in Fig. 1 thereby releasing the spring 90 from the
5 spring abutment member 92. The nut 80 has a rivet shoulder 80A to retain the nut to the bell cover 78. Although a coil spring 90 is shown, other types of springs such as an annular disc spring may be used.

To provide a service brake, a bladder 70
10 is contemplated between the intermediate wall 62 and the backing plate 52 of brake shoe 50. The bladder 70 may be supplied with a gaseous fluid under pressure by an inlet similar to inlet 108 and tube 106.

During an emergency or parking brake mode,
15 the springs 90 urge against the spring abutment plate 92 which in turn presses the legs 94 against the backing plate 52 of the brake shoe 50 to press the brake linings 54, 56 and 58 against the wear surfaces on the brake discs 22 and 24.

In other words, when the parking brakes or
20 service brakes are applied, the pressure from the brake shoe assembly 50 moves the disc 22, brake lining 56 and disc 24 axially such that the friction surfaces 22a,b, 24a,b on discs 22, 24 frictionally
25 engage the brake linings 54, 56 and 58.

Thus, the springs 90 provide a safety
brake, for the vehicle which would typically be a truck, tractor, or trailer. Once the truck or tractor is in operation, and the safety brakes are to be
30 released, air pressure would be supplied to the bladder 68 by means of tube 106 and inlet 108, thereby expanding the bladder 68 to move the spring abutment member 92 axially to overcome the springs 90 and thus removing the pressure on the brake shoe 50,
35 thereby allowing the discs 22 and 24 and thus the wheel to rotate freely. During the operation of the

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vehicle, when it is necessary to apply the active brakes, air pressure would be directed through inlet 128 (Fig.3) to the bladder 70 in order to move the brake shoe 50 axially to positively apply the
5 brakes. At the same time, air pressure could be released from the bladder 68, if necessary, although it is contemplated that the safety brakes would normally be kept released during operation.

As a safety feature, if the air pressure
10 was to fall under a predetermined level, the springs 90 would overcome the bladder 68 and cause the safety brakes to be applied.

A quick release valve 126 is located on the intermediate wall 62 and communicates with the
15 bladder 70. The quick release valve 126 will operate when it is required to deflate the bladder 70. At the same time the exhaust from the quick release valve will be directed along the intermediate wall 62 through ventilation channels 64 thereby enabling the
20 intermediate wall 62 to be cooled as well as the adjoining parts of the housing such as plate 66. The gas under pressure within the bladder 70 cools during decompression as it is released.

On the other hand a choke or restricted
25 passage 106A is provided on the conduit 106 to provide a slow release from the bladder 68 in order to avoid sudden violent application of the safety brakes while the vehicle is moving if a service brake malfunction should occur. A time delay valve might
30 also be provided instead of the choke.

It has been contemplated to interconnect the bladders 68 and 70 by suitable valves to allow air to pass from one bladder to the other in the event that it is desirable to apply the parking

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brakes and the service brakes simultaneously. However, in most cases, the bladders 68 and 70 would be operated independently.

5 The end edge of the sleeve 16 may be provided with teeth and an antilock-brake sensor or counter sensor 150 may be mounted to the intermediate wall 62 as shown in Fig. 1 for the purpose of sensing the movement of the teeth 151 as the adapter sleeve 16 rotates.

10 As shown in Fig. 2 the brake assembly is provided with a thermal sensor 102 connected to the intermediate wall 62 and having a lead 104. A thermal sensor 100 may be provided on the housing wall 28 with a lead 105 extending through a passage 96 provided for in the housing wall 30. The thermal
15 sensors 100 and 102 can provide temperature data with respect to the heat generated in the disc brake assembly, particularly near the disc. For instance the sensor 100 is right at the housing wall 28 next
20 to the brake lining 58 near the disc 24. The thermal sensor 102 will indicate the temperature of the intermediate wall 62. Other sensors may be provided. The sensors 100 and 102 communicate with a temperature indicator on the control panel in the vehicle.
25 Only one wheel may need be monitored in such a manner as it will give an indication of the type of heat generated in all the wheels of the same vehicle.

A warning device, connected to the brake thermal sensors, may be provided on the control panel
30 in the cab. The warning device may be an audible signal such as a buzzer or a recorded voice, or a visual diode graphic screen with different colours to provide information on the temperature of the brakes. As is well known when the temperature of the brakes
35 reaches a certain temperature, the brake pads begin to break down chemically, causing brake fading. The

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warning device could alert the operator to stop the vehicle in order to allow the brakes to cool down before the brakes reach a temperature level that might cause failure.

5 Another feature provided in the brake assembly described herein is a wear sensor as shown in Figs. 2 and 3. Because of the particular axial movement of the present brake assembly a wear sensor can be provided between the housing wall 26 and the
10 spring abutment member 92 and the distance between the two elements measured, particularly when the brakes are applied through the parking brakes under the urging of springs 90.

 In one embodiment as shown in Fig. 2 the
15 wear sensor 112 includes a rubber cap 114 and a plunger 116 urged by a spring 118 within a blind sleeve 120. A bearing sleeve 122 is provided within the sleeve 120 to allow the plunger to slide towards the spring abutment member 92 under the urging of the
20 spring 118. The plunger is provided with a flange 124 to receive the spring 118.

 Another form of wear sensor is shown in Fig. 3. Wear sensor 130 is an electronic sensor including a plunger 132, spring mounted within the
25 sensor 130, and urged against the spring abutment member 92. Sensor 130 communicates with a brake wear indicator on the control panel in the cab. Only one wheel need be monitored as it give a reliable indicator of the amount of wear occurring at all the
30 wheels of a vehicle.

 A still further wear sensor could be provided by allowing an opening in the housing wall 26, closed by a rubber nipple 110. When the rubber nipple is removed a measuring gauge can be

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inserted to determine the distance between the wall 26 and the spring abutment member 92 when the parking brake is applied.

It is also contemplated to provide the
5 brake sensors on the housing wall 28 so that the measurements can be taken against a backing plate associated with brake shoe 58 when the latter is made to move axially and the bladder 70 is mounted on the wall 28 (not shown). The service brake must be ap-
10 plied in order to take a proper reading.

With the use of the brake wear sensors or gauges a warning device can be provided on the control panel in the cab of the vehicle which would include an audible signal such as a buzzer when the
15 brake linings and discs have been worn to a predetermined level to at least warn the operator to replace the brake linings and discs or at least plan the maintenance thereof. It may even be contemplated to provide an interlock which would intervene at the
20 parking brake control valve to impede the release of the parking brakes when the brake wear has exceeded accepted levels of wear. In any event the brake wear system can give warning or control at different levels of brake wear.

25 A ventilation system for the disc brakes is provided. As partially, previously described and shown in Figs. 1 and 9, openings 148 are located in the intermediate wall 62 and as shown in Fig. 4 a plenum 134, in the form of an annular cover, may be
30 placed over the openings 148. The plenum 134 communicates with a scoop 136. The scoop 136 may be mounted on the housing wall 26 and would be facing the normal direction of travel of the vehicle so that air flow would be deflected into the plenum 134,
35 through the openings 148 to the discs 22 and 24 and in particular through the openings 36 and 38. Because

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of deflector or baffle 48 the air would be forced upwardly through the ventilation channels 46 of the discs 22 and 24. The baffle 48 could be eliminated if the disc 24 is closed to the adapter sleeve 16. The
5 discs 22 and 24 act as impellers creating a negative pressure in the area of the openings 36 and 38 thereby drawing air and pumping it to the periphery of the discs and exhausting it through the ventilation openings 32 allowing a great amount of heat to
10 be dissipated in this way. The scoop 136 and the plenum 134 may be a molded plastic member with a hinge 138 molded therein along with nut and bolt adjustments 140 to open or reduce the opening of the scoop 136.

15 It has been contemplated to use this ventilation system for a different purpose, such as in an aircraft utilization. Accordingly, by providing a similar brake configuration on the wheels of the landing gear of an aircraft, that is with scoop 136,
20 ventilation openings 32 and ventilated discs 22 and 24, a considerable flow of air can be passed through the (released) brakes ventilation system causing the wheels to rotate. It is particularly useful to have the wheels rotating at an equivalent
25 ground speed, at the moment of landing. In order to control the rate of rotation of the wheels, that is so that they do not overrotate, the scoop 136 may be remotely adjusted and the active brakes could be applied. The wheel speed may be calibrated to the
30 ground speed of the aircraft using a microprocessor using information from the counter sensor 150 and the aircraft ground speed data. The precise rate of rotation could be achieved by having the microprocessor modulate the scoop opening and the brakes
35 to compensate for the excess of torque generated by

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the air flow through the brakes. This would be an important safety factor with respect to aircraft tires.

A fragment of a brake disc 22 is shown in Figs. 6 and 7 with the surfaces 22A and 22B illustrated. A groove 142 extends somewhat radially of the surfaces 22A and 22B and has a semi-circular cross-section. In a specific example, the groove may be 0.09" in depth with a width of 0.25" and a radius of 1/8 of an inch. It has been found that the provision of such a groove allows air to enter, when the brakes are released and the discs are rotating, to form a slight air cushion between the brake linings and the friction surface on the disc, thereby eliminating dragging and helping to cool the friction surfaces. At the same time the groove allows the brake surfaces to be cleaned by providing a drainage channel for any liquid forming on the brake linings or debris between the friction surface of the disc and the linings.

It has also been found that by providing a coating on the disc brake surface the heat is more easily dissipated. This coating may be a ceramic with aluminum particulates mixed therein and which has a particular heat sink and wear resistance properties. The coating may also be titanium carbo-nitride or chromium carbide. A coating is presently being developed by "SERMATECH INTERNATIONAL INC." for military purposes.

It has also been contemplated to provide a spray mix where water is sprayed into the plenum 134 through opening 134a to mix with ventilation air being deflected into the brake assembly to enhance the cooling of the brake assembly.

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In the present embodiment, and as shown in Fig. 8, the bladder 70, which is in the form of an annular ring, is provided with an external annular dust cap 70a and an internal dust cap 70b. The dust caps 70a and 70b are provided to prevent debris from entering between the accordion like fins formed in the bellows-like bladder.

In the embodiment shown in Fig. 10, the bladder 290 adjusts the distance between lining 273 and friction surface 232a of disc 232, as will be described. In this embodiment, plate 223 is provided with integral posts 223a, which slide in bushings 266 mounted to the circumferential wall 226. The bushings 266 prevent posts 223a from jamming and thus plate 262 to slide parallel to intermediate wall 244. These posts 223a engage against the movable plate 262. Posts 264 extend from plate 262 to engage the backing plate 272.

A bladder 290 is provided between plate 223 and housing wall 222 which is bolted to the housing walls 226 and 248, as shown. The bladder 290 may be oil or grease filled. In either case, the increase of the volume in the bladder 290 will tend to distance the plate 223 from the wall 222, thereby moving the parking brake assembly including spring 256, spring abutment plate 262, posts 264, backing plate 272, and lining 273 closer to the disc 232. When the posts 223a have engaged the plate 262, the bladder 290 is used to compensate for brake disc or lining wear by pressing the plate 223 and posts 223a against the cage formed by plate 262 and posts 264.

As shown in Fig. 10, the bladders 282 and 284, which are operated by air pressure, can be controlled to either act as a positive force to apply the brakes, that is, when air pressure is increased in bladder 284 and bladder 282 is deflated, or to re-

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move the brakes against the force of spring 256 by increasing the air pressure in bladder 282 and deflating bladder 284.

It is also contemplated that the bladders 70, 284, in Figs. 1 and 10 respectively, could be located between the housing walls 28, 224 and a backing plate for brake linings 58, 238.

Instead of the bladder 290, the compensation for brake wear could be provided by the compensating ring 229. Ring 229 is a segmental ring which can easily be removed from between intermediate wall 244 and flange 226b of housing wall 226. A compensating ring (not shown) may be provided between intermediate wall 244 and flanges 248b and 226a. The compensating ring 229 could also be placed between the housing wall 222 and the mounting flange 226c therefor. A compensating ring (not shown) would then be mounted between wall 222 and flange 248a. The idea is to allow for a decrease of the axial length of the housing 216 in order to compensate for wear of all parts of the braking system.

Fig. 11 shows an embodiment of the device for adjusting the spring length to increase the force against the brake shoes or for compensating for brake wear. In the embodiment shown, a grease nipple 392 in cap 361 can be utilized to insert grease or oil into the cavity 390 to displace the wall 355 in cylinder 354. When it is required to release the spring 356, the plug 393 can be released to allow the grease or oil to exit, thereby allowing the wall 355 to slide towards the cap 361.

In another embodiment, disc springs 490 could be used instead of coil springs 90, 256, 356. A single disc spring is illustrated in Fig. 12a and the characteristics thereof are shown in Fig. 12b. For a more ample description of the disc spring reference

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is made to the "Schnorr Handbook for Disc Springs" published 1983 by Adolf Schnorr GmbH & Co. KG, P.O. Box 60, D-7032 Sindelfingen 6, Germany. It has been found that by stacking disc springs in different configurations, different spring rates can be obtained.

One characteristic of the disc spring which is particularly useful in the present invention is that the full deflection spring load characteristic does not decrease until a large percentage of the spring deflection has occurred, i.e. approximately 50% to 70% when h_o/t is larger than 1.6 and smaller than 2.0. The distance represented by the travel within these limits may represent the compensation for wear. With other spring characteristics the same travel, i.e. 50% to 70% would result in a significant reduction in the spring load characteristic as shown in Fig. 12b where

	h_o	represents the formed height of an unloaded single disc in mm;
20	t	represents the thickness of a single disc spring in mm;
	S	is the deflection in mm;
	K	= F/F_c ;
	F	is the spring load;
25	F_c	is the calculated load given by a single disc pressed flat.

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CLAIMS:

1. A disc brake assembly for a vehicle wheel (12) on a vehicle, wherein the wheel (12) includes a hub journaled (14) to an axle (10) on the vehicle, the disc brake assembly is within the confines of the wheel (12) and concentric with the axle (10), the disc brake assembly including a housing (18) mounted to the vehicle and at least a radial disc (22,24) within the housing (18) and means (16) mounting the disc (22,24) to the wheel, the disc (22,24) having at least a first radial planar friction surface (22a) and a first brake shoe (50) provided adjacent the first planar friction surface (22a) movable axially towards and away from the first friction surface (22a) of the disc (22) for friction engagement therewith and release thereof, means provided for restraining the first brake shoe (50) from rotating with the disc (22,24), an intermediate wall member (62) mounted within the housing (18) and fixed thereto extending parallel with the radial disc (22,24) and located such that the first brake shoe (50) moves axially between the intermediate wall (62) and the radial disc (22), a movable spring abutment means (92) mounted for axial movement within the housing (18) between the intermediate wall (62) and the housing wall (26) such that the intermediate wall (62) is between the movable spring abutment means (92) and the first brake shoe (50), rigid pusher link members (94) extending between the spring abutment means (92) and the first brake shoe (50) pass the intermediate wall (62) such that the spring abutment means (92) moves axially with the first brake shoe (50); a spring means (90) extending between the housing wall (26) and the spring abutment means (92) such that the spring (90) urges against the spring

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abutment means (92) to press the first brake shoe (50) against the first friction surface of the disc (22a), and a first fluid bladder (68) being provided between the intermediate wall (62) and the spring abutment means (92) whereby the first bladder (68), when expanded, forces the spring abutment means (92) to overcome the spring means (90) to release the first brake shoe (50) from the first friction surface (22a) of the disc (22).

2. A disc brake assembly as defined in claim 1, wherein the first brake shoe (50) includes a backing plate (52) mounting brake linings (54), the backing plate (52) extending parallel to the intermediate wall (62) and being in direct contact with the link members (94).

3. A disc brake assembly as defined in claim 2, wherein a second fluid bladder (70) is provided between the backing plate (52) and the intermediate wall (62) such that, when the active brakes are applied, fluid pressure is applied to expand the second bladder (70) so as to urge the first brake shoe (50) against the first friction surface (22a) of the disc (22).

4. A disc brake assembly as defined in claim 1, wherein the radial disc (22) is provided with a second radial friction surface (22b) on the other side of the disc (22) relative to said first friction surface (22a) of the disc, and a second brake shoe (56) is mounted within the housing (18) adjacent the second friction surface (22b) of the disc (22), means are provided for restraining the second brake shoe (56) from rotation with the disc (22) but allowing axial movement, and the means for

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mounting the disc to the wheel includes an adapter sleeve (16) fixed to the wheel (12) and provided with axial splines (44) such that the disc (22) is capable of axial movement.

5. A disc brake assembly as defined in claim 1, wherein the intermediate wall member (62) and the housing (18) are mounted to a radial mounting ring (20) mounted to the axle (10).

6. A disc brake assembly as defined in claim 1, wherein the housing means (18) is an annular housing provided with a central axial opening through which the axle (10) extends therethrough, and a mounting ring (20) in the form of an annular ring is mounted to the axle (10) to which the housing (18) and the intermediate wall (62) are mounted, the disc mounting means includes an adapter sleeve (16) having axial splines (44), the disc (22) is an annular disc mounted on the axial splines (44) of the adapter sleeve (16) which extends from the wheel (12) through a central opening (42) of the disc.

7. A disc brake assembly as defined in claim 1, wherein each spring (356) is received in a cylindrical sleeve (354) mounted in the housing wall and a piston (355) slides in the sleeve (354) and forms a cavity (390) with an end wall (361), and means (392) are provided for injecting a fluid within the cavity (390) to move the piston (355) and thus the spring (356) to compensate for wear on the brake shoe and the radial disc.

8. A disc brake assembly as defined in claim 1, wherein a piston (223) is slidable within the housing (216) and an expandable bladder (290) is

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provided in the housing (216) between the piston (223) and the wall (222), means are provided for supplying fluid into the bladder (290) to expand the distance between the wall (222) and the piston (223) to move the spring means (256) to compensate for wear.

9. A disc brake assembly as defined in claim 1, wherein compensating means are provided in the form of a compensating ring (152,229) supplementing the length of an axial cylindrical wall (30,226) of the housing (18,216), and when the compensating ring (152,229) is removed from the cylindrical wall (30,226), the axial length of the housing (18,216) is reduced, thereby compensating for the wear on the brake shoe lining (54,56,58,238,273) and the disc (22,24,232).

10. A disc brake assembly as defined in claim 9, wherein the housing (216) includes an outer cylindrical, axially extending wall member (226) having a pair of integral radial flanges (226a,226b) bolted together, and a compensating ring (229) between the flanges (226a,226b) whereby, when it is required to reduce the axial length of the housing (216) to compensate for wear on the brake parts (238,232,273), the compensating ring (229) is removed from the flanges (226a,226b) of the cylindrical wall (226), and the flanges (226a,226b) are bolted together.

11. A disc brake assembly as defined in claims 1, 2 or 3, wherein the disc assembly comprises a first and second radial disc (22,24) and each disc has two friction surfaces (22a,22b,24a,24b) and a brake lining (56) is provided between the first and

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second radial discs (22,24), and means are provided for restraining the brake lining (56) from rotating with the discs (22,24) but allowing axial movement thereof.

12. A disc brake assembly as defined in claim 11, wherein the second radial disc (24) is provided with a second radial friction surface (24b) on the other side of the second disc relative to the first friction surface on the first radial disc, and a second brake shoe (58) is mounted within the housing (18) adjacent the second friction surface (24b) of the second disc (24), the first and second brake shoes (50,58) each including a backing plate (52) mounting brake linings (52,58), a second fluid bladder (70) is provided between one of the backing plates (52) and a fixed portion of the housing (62) adjacent the backing plate (52) such that, when the service brakes are applied, fluid pressure is applied to expand the second bladder (70) so as to urge one of the first and second brake shoes (50,58) against a respective first and second friction surfaces (22a,24b) of the discs (22,24).

13. A brake assembly for a vehicle wheel having a housing (18) adapted to be contained in the wheel (12), mounting means (20) for securing the housing (18) to the vehicle, at least an annular rotor disc (22,24) mounted within the housing (18) for rotation with the wheel (12), the disc (22,24) having a plurality of circumferentially spaced channels (46) extending from the periphery of the disc (22,24) towards the center to communicate with central openings (36,38) at the inner margin of the annular disc (22,24) such that air can pass from the central openings (36,38) at the inner margin of the

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annular disc (22,24) to exhaust at the outer periphery thereof in order to dissipate heat generated at the disc (22,24), means defining openings (148) in the housing to allow air flow from the exterior of the housing (18) through the housing openings (148), means (48) for directing air flow through the housing (18) to the central openings in the disc and deflector means (136) mounted on the exterior of the housing (18) for diverting air to the openings (148) in the housing.

14. A brake assembly as defined in claim 13, wherein the plurality of channels (46) are generally radially directed.

15. A brake assembly as defined in claim 13, wherein the deflector (134,136) on the exterior of the housing is a plenum (134) having an annular component covering said openings (148) in the housing (18) and a scoop (136) having an open end directed in the direction of air flow and the scoop converging to the plenum (134).

16. A brake assembly as defined in claim 15, wherein the scoop (136) is adjustable to control the dimensions of the open end.

17. In a brake assembly, an annular rotor disc (22,24) having at least one radial planar braking surface, (22a,b,24a,b) brake shoe means (50) for engaging the braking surface (22a...) of the disc (22,24) wherein a shallow groove (142) is defined across the braking surface (22a...) generally radially thereof whereby an air cushion can be provided between the rotor disc (22,24) and the brake shoe means (50) when the brake shoe means (50) is

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released from the braking surface (22a...) of the disc (22,24) and the groove (142) provides a drainage channel for removing debris from between the brake shoe means (50) and the braking surface (22a...) of the disc (22,24).

18. In a brake assembly, an annular rotor disc (22,24) having at least one radial planar braking surface (22a,b,24a,b), brake shoe means (50) for engaging the braking surface (22a...) of the disc (22,24) wherein the braking surface (22a...) is provided with a coating chosen from a composition including ceramic and aluminum particles, Silicon, Carbide, Titanium, Carbonitride, whereby heat is dissipated from the surface and wear resistance is enhanced.

19. A brake assembly for a vehicle wheel (12) having a brake housing (18) adapted to be contained in the wheel (12), mounting means (20) for securing the housing (18) to the vehicle, at least an annular rotor disc (22,24) mounted within the housing (18) for rotation with the wheel (12), the disc (22,24) having a plurality of circumferentially spaced channels (46) extending from the periphery of the disc towards the center to communicate with central openings (36,38) at the inner margin of the annular disc (22,24) such that cooling air can pass from the central openings (36,38) at the inner margin of the annular disc (22,24) to exhaust at the outer periphery thereof in order to dissipate heat generated in the disc (22,24) characterized in that the disc (22,24) is composed of an aluminum composite known as DURALCAN (T.M.).

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20. A brake assembly as defined in claims 1, 13, 17, 18 or 19, wherein there is at least a pair of annular rotor discs (22,24).

21. A disc brake assembly for a vehicle wheel (12) on a vehicle wherein the wheel (12) includes a hub journaled (14) to an axle (10) on the vehicle, the disc brake assembly is within the confines of the wheel (12) and concentric with the axle (10), the disc brake assembly including a housing (18) mounted to the vehicle and at least a radial disc (22,24) within the housing (18), and means (16) mounting the disc (22,24) to the wheel (12), the disc (22,24) having at least a first radial planar friction surface (22a,b,24a,b) and a first brake shoe (50) provided adjacent the first planar friction surface (22a) movable axially towards and away from the first friction surface (22a) of the disc (22) for friction engagement therewith and release thereof, an intermediate wall (62) member mounted within the housing (18) and fixed thereto and extending parallel with the radial disc (22,24) and located such that the first brake shoe (50) moves axially between the intermediate wall (62) and the radial disc (22), movable spring abutment means (92) mounted for axial movement within the housing (18) between the intermediate wall (62) and the housing wall (26) such that the intermediate wall (62) is between the movable spring abutment means (92) and the first brake shoe (50), rigid pusher link members (94) extending between the spring abutment means (92) and the first brake shoe (50) and passing by the intermediate wall (62) such that the spring abutment means (92) move axially with the first brake shoe (50), a spring means (90) extending between the housing wall (26) and the spring abutment means (92)

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such that the spring (90) urges against the spring abutment means (92) to press the first brake shoe (50) against the first friction surface (22a) of the disc (22) in a parking brake mode, the brake shoe (50) including linings (54) to engage the first planar friction surface (22a) of the disc (22) and wear gauge means (110,112,130) including a plunger (116,132) which can extend between the housing wall (26) and the spring abutment means (92) such that the distance between the housing wall (26) and the spring abutment means (92) can be monitored when in the parking brake mode and the data therefrom can be communicated to determine the wear of the linings (54,56,58) and discs (22,24) of the brake assembly.

22. A brake assembly as defined in claim 21, wherein an aperture is provided in the housing wall (26) to allow the plunger to be passed therethrough.

23. A brake assembly as defined in claim 21, wherein the brake wear gauge means (110,112,130) includes a spring mounted plunger means (116) provided on the housing wall (26) and wherein the spring (118) urges the plunger (116) against the spring abutment means (92) and a portion of the plunger extends beyond the housing wall (26) whereby the brake wear will be gauged by determining the amount of protrusion of the plunger (116) exterior of the housing wall.

24. A brake assembly as defined in claim 21, wherein the brake wear gauge is in the form of an electronic measuring device (130) in association with a plunger (132) urged against the spring abutment means (92) to determine the distance between

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the housing wall (26) and the spring abutment means (92) and means for communicating the results to a display means.

25. A disc brake assembly for a vehicle wheel (12) on a vehicle wherein the wheel (12) includes a hub journaled (14) to an axle (10) on the vehicle, the disc brake assembly is within the confines of the wheel (12) and concentric with the axle (10), the disc brake assembly including a housing mounted to the vehicle and at least a radial disc (22,24) within the housing (18) and means (16) mounting the disc (22,24) to the wheel (12), the disc (22,24) having at least a first radial planar friction surface (22a,b,24a,b) and a first brake shoe provided adjacent the first planar friction surface movable axially towards and away from the first friction surface (22a) of the disc (22) for friction engagement therewith and release thereof, means for axially moving the first brake shoe means away from the housing wall to engage the first friction surface of the disc, wear gauge means adapted to extend between the housing wall and the brake shoe means for determining the relative distance between the housing wall and the brake shoe such that the distance can be monitored when the brakes are applied and the data therefrom can be communicated to determine the wear of the linings and the discs of the brake assembly.

26. A disc brake assembly for a vehicle wheel (12) wherein the wheel (12) includes a hub journaled (14) to an axle (10) on the vehicle, the disc brake assembly is within the confines of the wheel (12) and concentric with the axle (10), the disc brake assembly includes a housing (18) mounted to the vehicle and at least a radial disc (22,24)

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within the housing (18) and means (16,44) mounting the disc (22,24) to the wheel (12), the disc (22,24) having at least a first radial planar friction surface (22a,b,24a,b), a first brake shoe (50) provided adjacent the first planar friction surface (22a) of the disc (22), movable axially towards and away from the first friction surface (22a) of the disc (22), for friction engagement therewith and release thereof, means provided for restraining the first brake shoe (50) from rotating with the disc (22,24), an intermediate wall member (62) mounted within the housing (18) and fixed thereto extending parallel with the radial disc (22,24) and located such that the first brake shoe (50) moves axially between the intermediate wall (62) and the radial disc (22,24), a movable spring abutment means (92) mounted for axial movement within the housing (18) between the intermediate wall (62) and the housing wall (26) such that the intermediate wall (62) is between the movable spring abutment means (92) and the first brake shoe (50), pusher link members (94) extending between the spring abutment means (92) and the brake shoe (50) passing through the intermediate wall (62) such that the spring abutment means (92) move axially with the brake shoe (50), spring means (90) extending between the housing wall (26) and the spring abutment means (92) such that the spring means (90) urges against the spring abutment means (92) to press the brake shoe (50) against the friction surface (22a) of the disc (22) in a parking brake mode, a first fluid bladder (68) being provided between the intermediate wall (62) and the spring abutment means (92) whereby the first bladder (68) when expanded forces the spring abutment means (92) to overcome the spring means (90) to release the brake shoe (50) from the friction surface (22a) of

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the disc (22,24) to release the parking brake mode, a second bladder (70) being provided between the intermediate wall (62) and the brake shoe (50) such that when expanded, service brakes will be applied by application of the brake shoe (50) to the friction surface (22a) of the disc, the disc brake assembly is characterized in that quick release valve means (126) are mounted to the intermediate wall (62) and communicate with the second bladder (70) in order to evacuate gas from the second bladder (70) to accelerate the modulation of the second bladder (70) and to circulate the gas along the intermediate wall in order to help dissipate heat therefrom.

27. A disc brake assembly for a vehicle wheel (12) wherein the wheel (12) includes a hub journaled (14) to an axle (10) of the vehicle, the disc brake assembly is within the confines of the wheel (12) and concentric with the axle (10), the disc brake assembly includes a housing (18) mounted to the vehicle and at least a radial disc (22,24) within the housing (18) and means (16,44) mounting the disc (22,24) to the wheel (12), the disc (22,24) having at least a first radial planar friction surface (22a,b,24a,b), a first brake shoe (50) provided adjacent the first planar friction surface (22a,b,24a,b) of the disc (22,24) movable axially towards and away from the first friction surface (22a,b,24a,b,) of the disc (22,24) for friction engagement therewith and release thereof, a bladder (70) being provided between a housing wall and the brake shoe (50) such that when expanded service brakes will be applied by application of the brake shoe (50) to the first friction surface (22a,b, 24a,b) of the disc (22,24), the disc assembly being characterized in that a quick release valve means

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(126) is mounted to the housing wall and communicates with the bladder (70) in order to evacuate gas from the bladder (70) to accelerate the modulation of the bladder.

28. A brake assembly as defined in claim 26, wherein temperature sensors (100,102) are provided on the intermediate wall (62) and at a housing wall (26,28) near the disc in order to determine the temperature of the brake assembly

29. A brake assembly as defined in claim 16, wherein the vehicle is an aircraft and the wheels are on the landing gear and wherein the airflow entering the scoop (136) and plenum (134) pass through the openings (148) in the housing to rotate the discs (22,24) and thus the wheels (12) and means (138) are provided to modulate the opening of the scoop and the brakes to calibrate the rate of rotation of the wheels with the ground speed of the aircraft.

30. A brake assembly as defined in claim 15, wherein the openings (148) in the housing are provided near the center of the housing axially arranged with the inner margins of the disc (22,24) and a deflector (48) is provided axially downstream of the disc relative to the openings (148) in the housing to direct the air radially outwardly through the channel in the disc.

31. A brake disc assembly as defined in claim 15, wherein an opening (134a) is provided in the plenum (134) to allow a cooling water spray to be

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injected in the plenum (134) to mix with the air entering the brake assembly to enhance the dissipation of heat.

32. A brake assembly as defined in claim 12, wherein dust caps (70a,70b) are provided along the inner and outer margins of the first and second bladders (68,70).

33. A brake assembly as defined in claim 1, wherein the spring means (90) includes circumferentially spaced apart openings (76) defined on the housing wall (26), bell covers (78) provided, one in each opening (76), the bell cover (78) having a beyonet engagement with the wall (26) at each opening (76) and a spring member (90) in each bell cover (78) extending between the bell cover (78) and the spring abutment means (92).

34. A brake assembly as defined in claims 1, 8, 21, 26 or 33, wherein the spring member (90,256,356) is a coil spring.

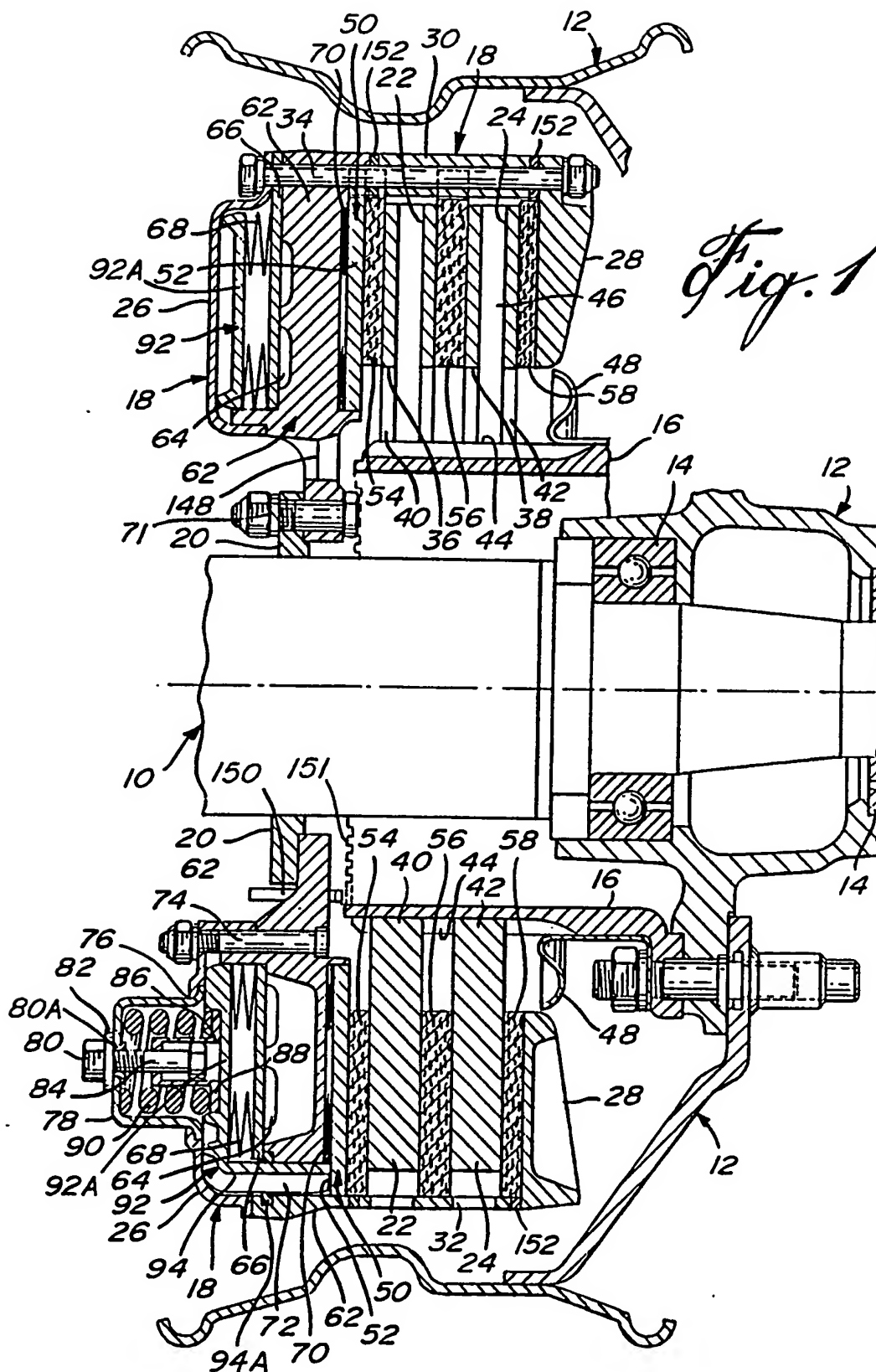
35. A brake assembly as defined in claims 1, 7, 8, 21, 26 or 33, wherein the spring member (90,256,356) is a spring disc.

36. A brake assembly as defined in claim 34, wherein a blind sleeve (86) is within the coil spring (90) and has a flange (88) remote from the bell cover (78) on which the coil spring abuts and a bolt (84) passes through the bell cover (78) to threadably engage the blind sleeve (86) so as to retain the spring.

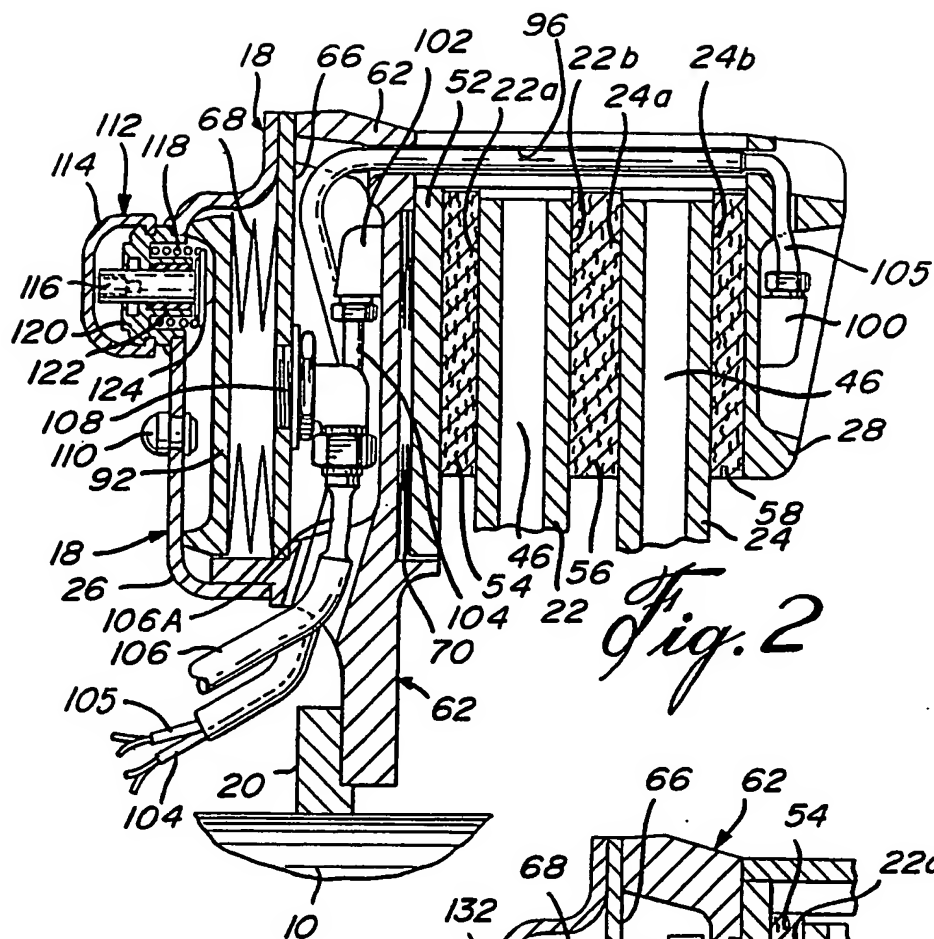
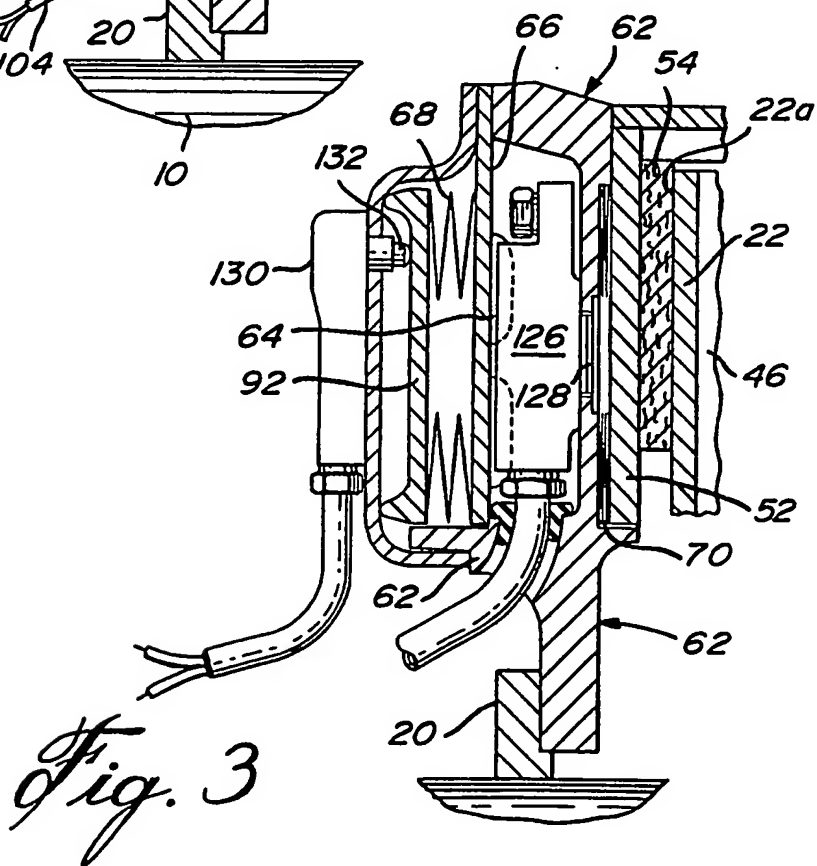
- 38 -

37. A brake assembly as defined in claim 1, wherein seal means (94A) are provided between each pusher link member (94) and the intermediate wall (62).

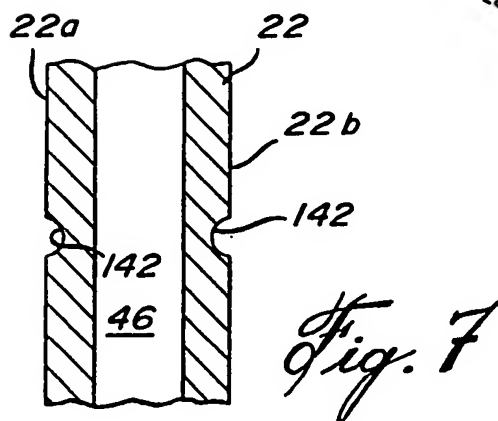
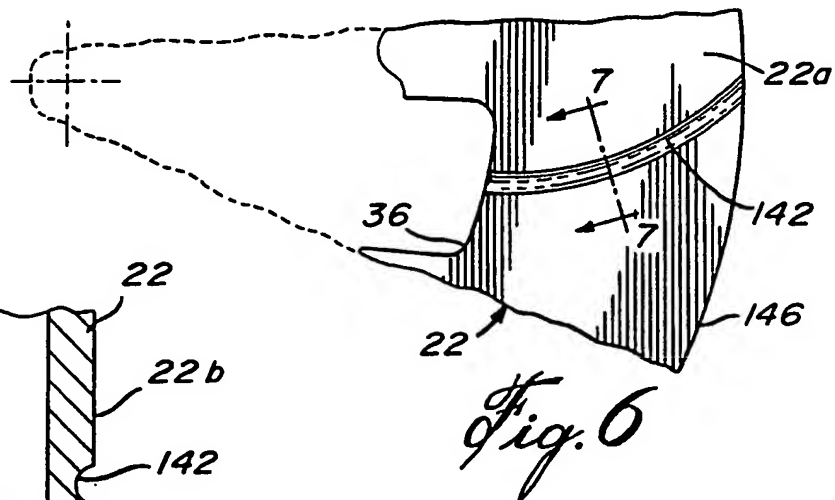
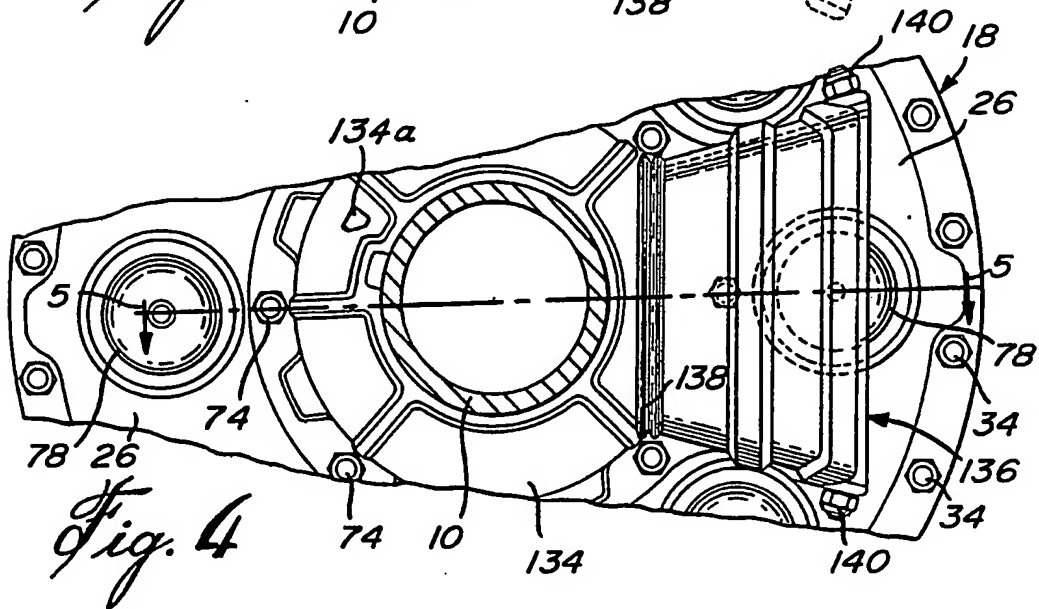
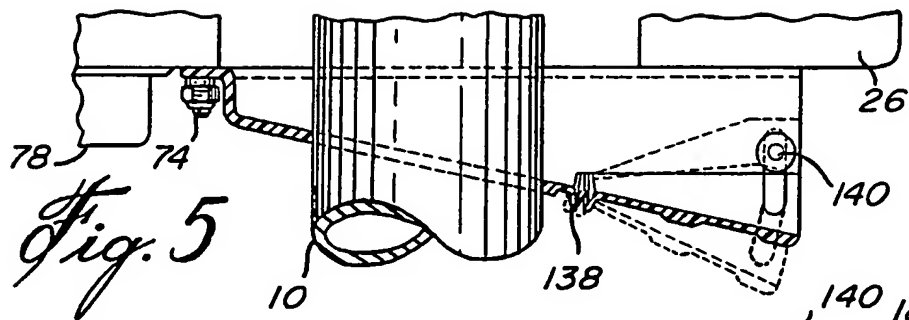
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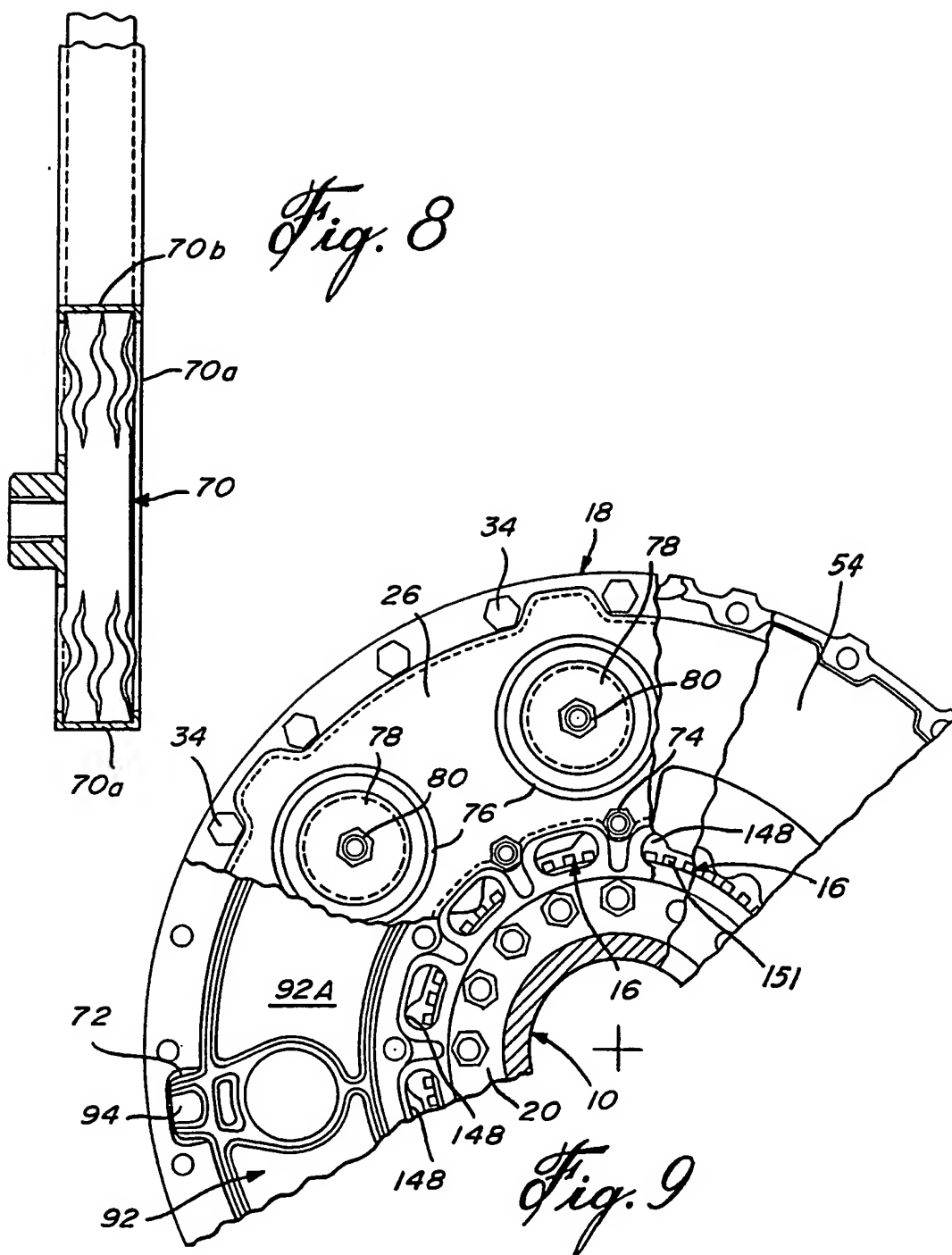
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*Fig. 2**Fig. 3*

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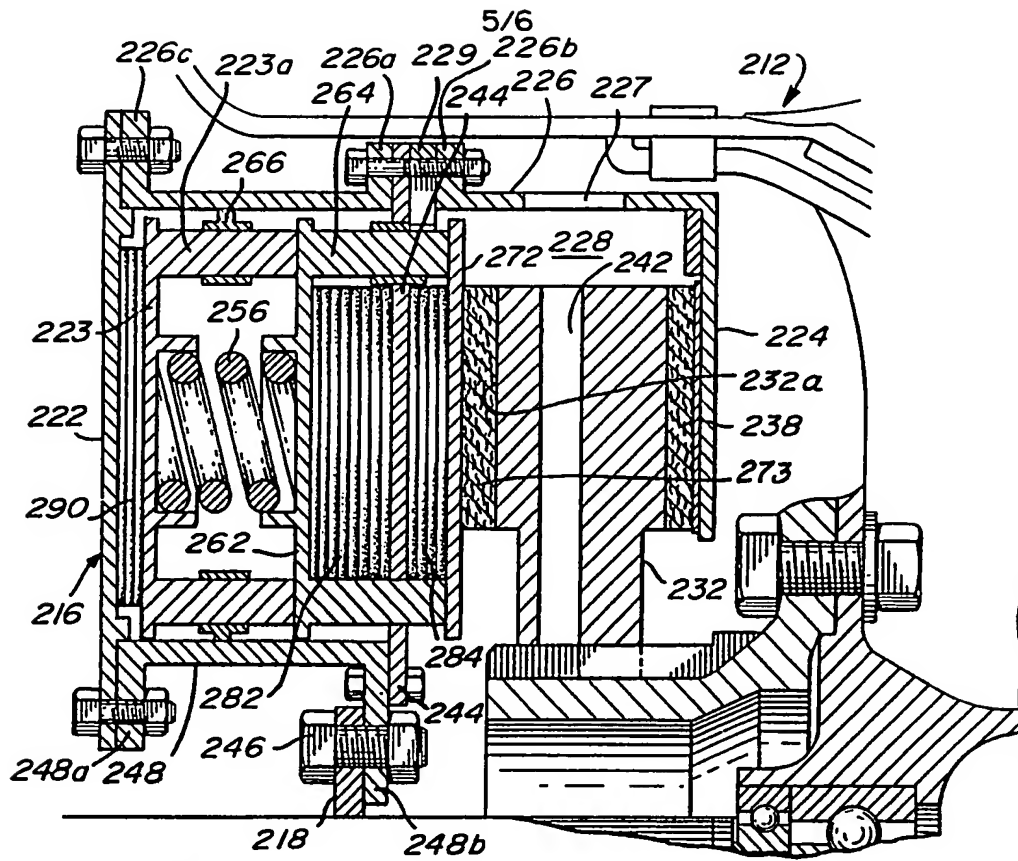


Fig. 10

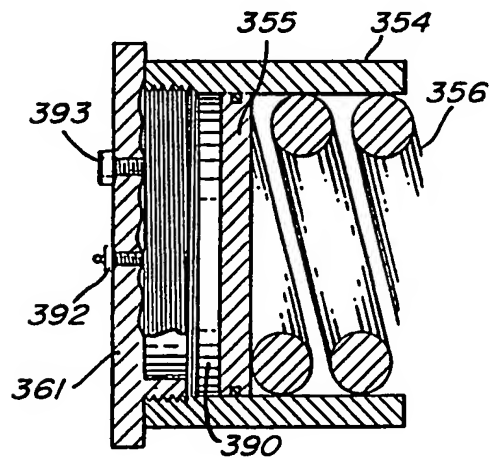
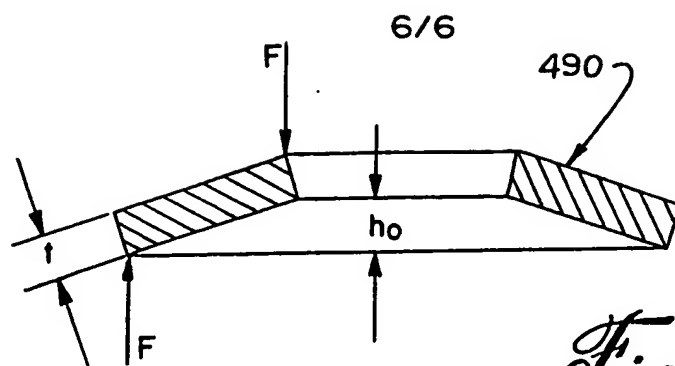
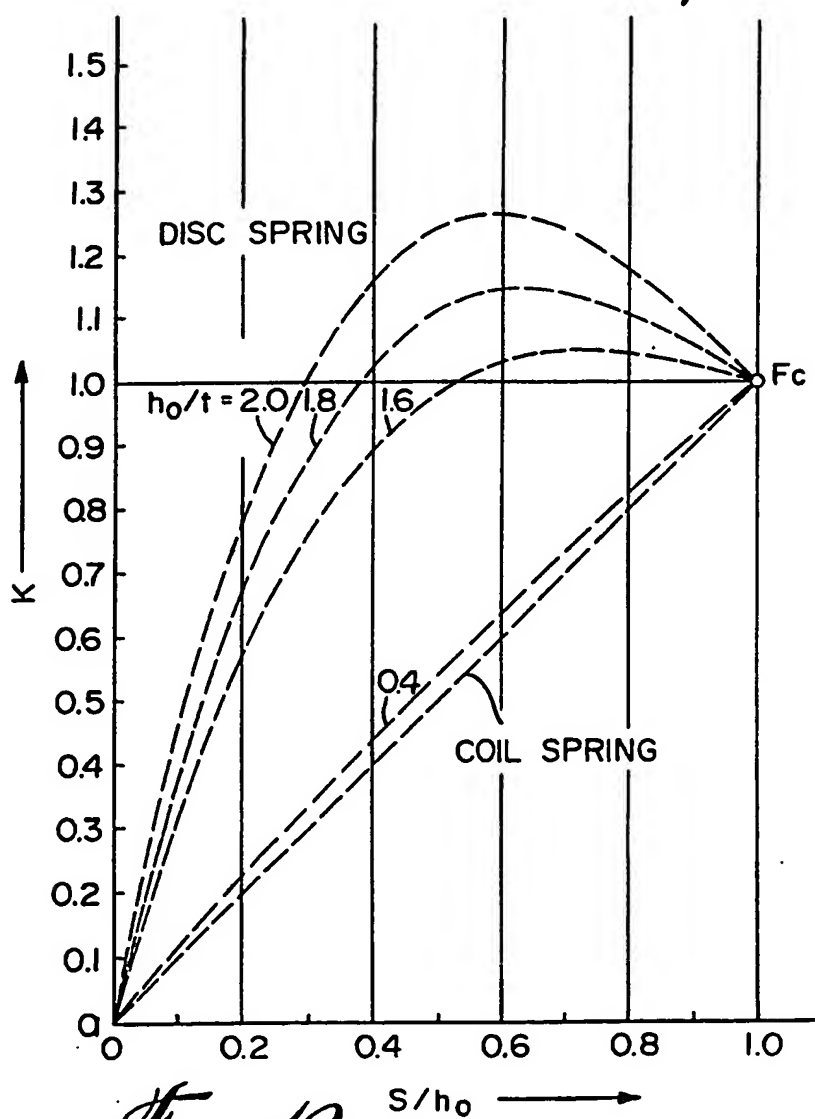


Fig. 11

*Fig. 12a**Fig. 12b*